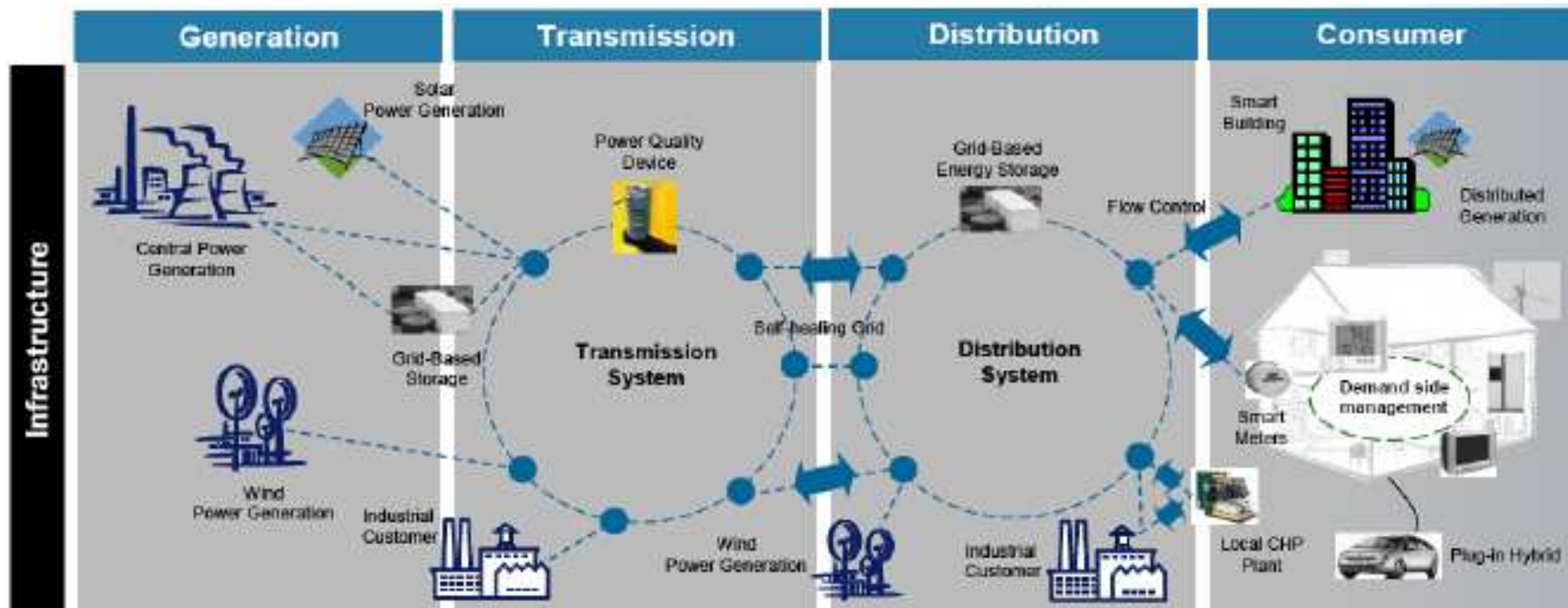




**Smart Grid architecture-
telecommunications technologies for
enabling looking-forward and viable
Smart Grid applications**

December 2010

Smart Grid: concept

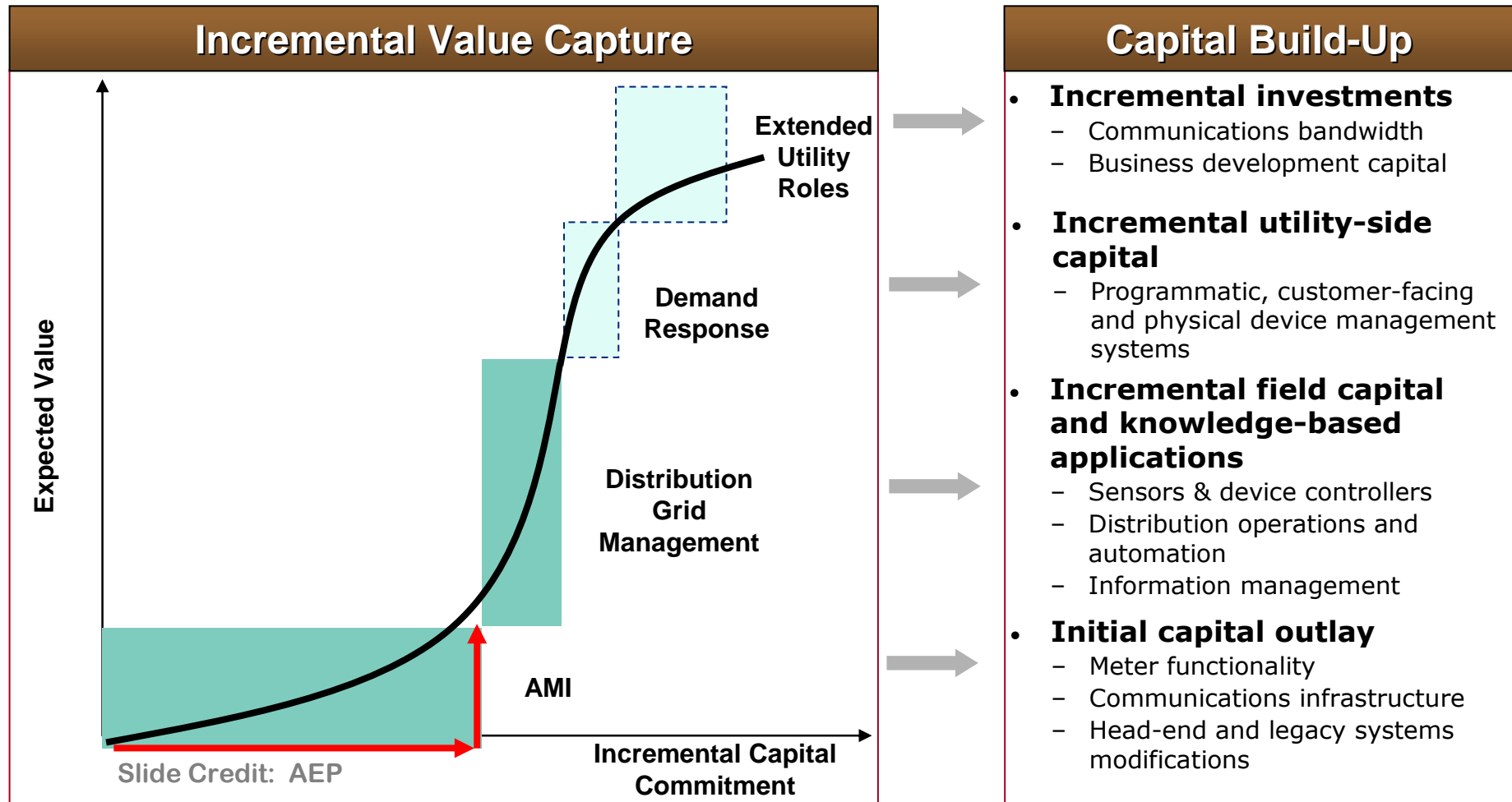


Smart Grid

- Scope & applications to be defined according to each own strategy
- Encompassing numerous domains & needs

The definition of Smart Grid has to be made according to the specific situation of the considered utility

AMI Initial Capital Outlay Foundation for the Future



- Initial investment related to smart metering/AMI/AMR being capex intensive but returning lesser value
- Smart metering seen as a transformative application as it forms the base to run advanced smart grid applications on an end to end infrastructure

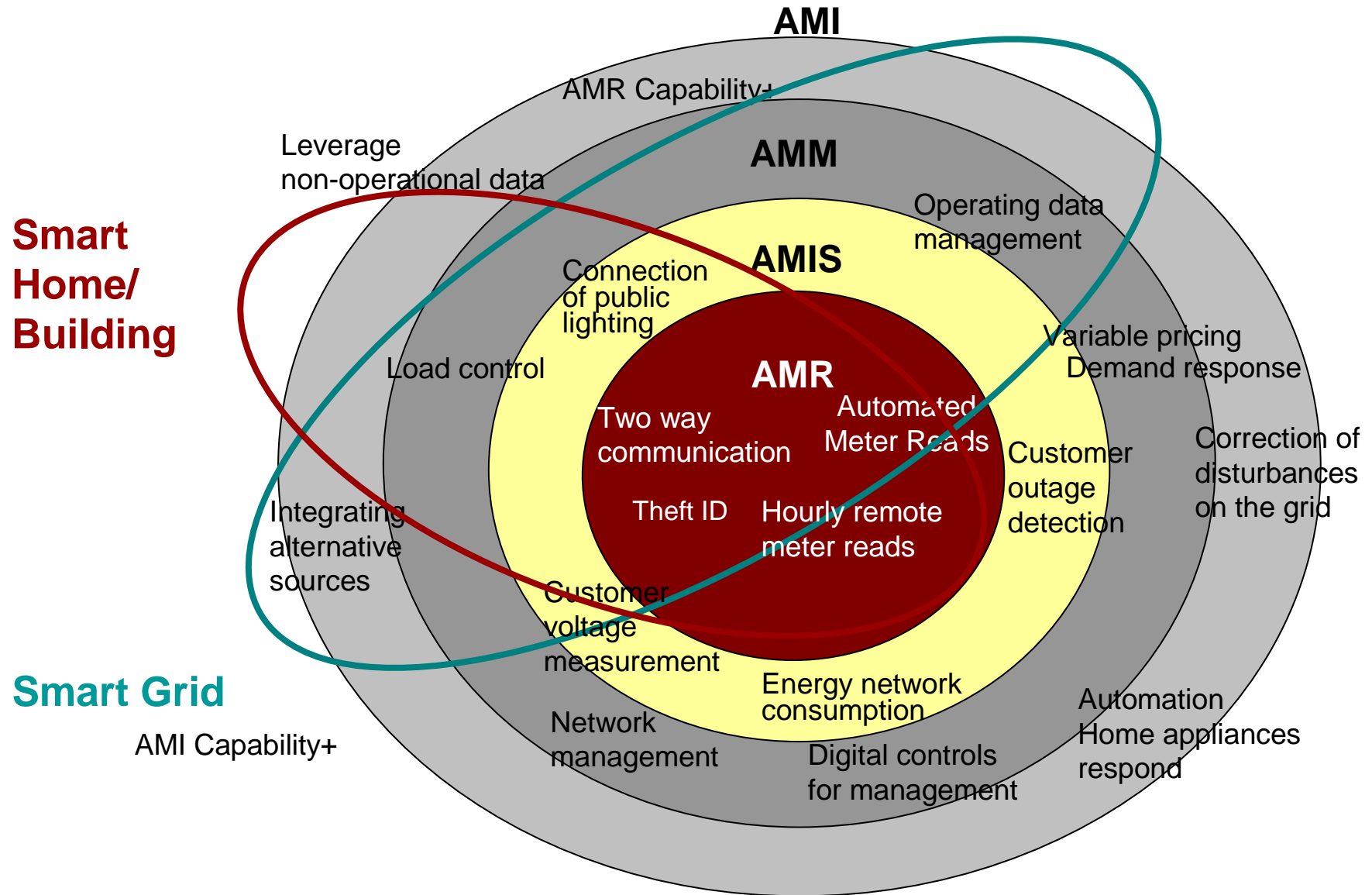
Numerous “Smart Grid” projects and regulatory push



Lessons to be drawn from significant deployments and pilots

- | | |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| ➤ Street lighting in Chicago by Duratel (WiFi) | ➤ Smart metering in Göteborg by Göteborg Energi (Zigbee + GPRS) |
| ➤ Renewable energy management in Hawaii by GE (PLC) | ➤ Renewable energy management in Singapore by The Singapore Energy Market Authority (pilots with fiber, WiFi and RF) |
| ➤ Smart metering in Australia by SP AusNet (WiMAX) | ➤ AMI in North Carolina by EnergyUnited (PLC) |
| ➤ Smart metering in Italy by Enel (Narrowband PLC) | ➤ Smart Metering in France by ERDF (Narrowband PLC) |
| ➤ AMI on MV in Senegal by Senelec (Broadband PLC) | ➤ Street lighting in Essone by Echelon (Narrowband PLC + GPRS) |
| ➤ Street lighting in Oslo by Echelon (Narrowband PLC + GPRS) | |

Advent of Smart Grid



Multi-Technologies Smart Grid

Communication infrastructure

- Broadband PLC
 - ATHEROS, MARVELL, Amperion, ibec, POWER PLUS COMMUNICATIONS
- WiMAX
 - intel, sENSUS, GRID NET, alvarion, GE, WiMAX FORUM
- DSL
 - Qwest, Alcatel-Lucent
- WiFi-mesh
 - AMBIENT, TROPUS networks, QUALCOMM, StrixSYSTEMS
- Satellite
 - HUGHES, iDIRECT
- Radio system
 - Tantalus
- ZigBee
 - nURI TELECOM
- Cellular network
 - Smart/Synch

Meters

- Narrowband PLC
 - PRIME ALLIANCE, meters and more, ECHELON, MAXIM INNOVATION DELIVERED
- Radio Frequency mesh
 - SILVERSPRING, Itron, Smart/Synch
- WiFi
 - TROPUS networks GREENER, SAFER, SMARTER
- Cellular network
 - elster, Itron, Landis+Gyr, Trilliant
- ZigBee protocol
 - Itron, Smart/Synch, ember
- WiMAX
 - TELVENT, Corinex, muNet, Itron, GE
- Broadband PLC
 - elster

In-home

- ZigBee Protocol
 - Energate, ONZO, comverge, greenbox, GE, ZigBee, ember, TENDRIL Smart Energy For Life, Itron
- WPC technology (Watt Pulse communication)
 - WATTECO
- Broadband PLC
 - HOMEPLUS POWERLINE ALLIANCE, Atheros, MARVELL, IEEE
- Z-Wave
 - HORSTMANN, Kamstrup
- Cellular network and WiFi
 - COOPER Power Systems, GainSpan, Telemetric Now part of sENSUS

A vast array of technologies to be chosen amongst. Current implementation shows some favourable trends for PLC and GPRS technologies, based on proprietary or open solution

Key applications scenario

Scenario 1 – Smart metering

Features

- Automatic Meter Reading (AMR)
- Remote connect/disconnect
- Associated devices monitoring (water, gas & heat meter, appliances below meter)

Telecommunication minimum requirements

- Two way (bidirectional) communication
- Long distance coverage, and possibility to make hops to reach isolated meters
- Multicast ability
- Meters reading at regular intervals (European regulation)

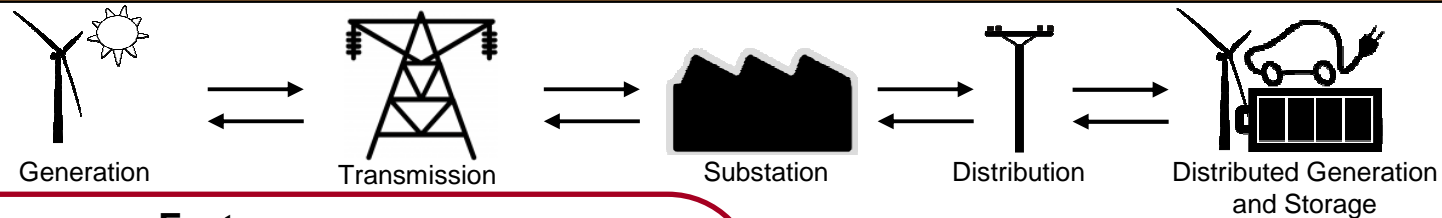
- Limited performance within basic low data rate automated reading architecture
 - ⇒ Small data rates (2kbps) not enabling several reads per hour, non continuous communication
- Specific needs of the utility must be translated into telecom requirements



Specific needs	Additional requirements	Characteristics needed
Instantaneous data collection (every minute)	Real time ability	Permanent connexion
Control of operating costs	Low power consumption	Less than 1 mW
Long distances to be covered	Passing through substations	Either high number of hops or long distances over km with a correct signal
Analysis, aggregation, storage, and action	Management of high data flows	Powerful computer and high storage capacities (750 terabyte of data per year for an every minute reading of 500k meters)
Monitoring of hundred thousands, millions of meters	Monitoring of millions of devices and sensors in future apps (in-home, on the grid)	400 Mbps for 500k smart meters read every minute

Key applications scenario

Scenario 2 – Renewable energy use



Features

- Full awareness of the generation capacity
 - ⇒ At the utility's power plants
 - ⇒ At the microgeneration level for distributed generation
 - ⇒ Monitoring on-site weather data analysis and transmitting it to the central
- Permanent reading of the electricity consumption and usage forecasts
- Enhancement of the renewable energy utilization with rapid response to peak-load conditions
- Electric Power System Areas islanding
- Integration with micro power sources (such as heat pumps) that lead to load shifts

Telecommunication requirements

- Two-way (bi-directional)
- Real-time communication
- Long distance communication for the utility's (renewable) energy plants (often far from populated areas)
- Redundancy to guarantee the transportation of the information
- IPv6 for the multiple appliances
- Broadband

Telecommunications needs

Larger information transfers: (on-site weather data gathering to be sent to the central for analysis)

Islanding: strategic sensors on the power lines require a minimum of 2 Mbps to diagnose and receive orders, from the customers to the concentrator

“ The 2-5 Mbits/s data rate should be considered indicative of an application with a relatively low to medium data rate production and may be used as a guideline. ”

D. Fischer, Senior Member, IEEE - [Developing a Communication Infrastructure for the Smart Grid](#)

Key applications scenario

Scenario 3 – Vehicle to the Grid (V2G)

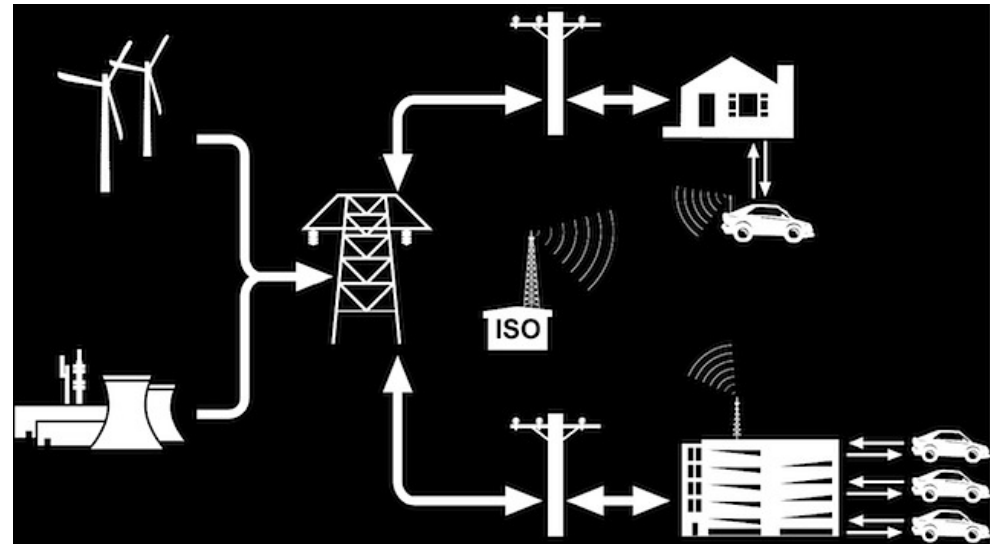
Features

- Automatic detection of the vehicle as a new source of energy when connected to the grid
- Automatic and strong management of the power production
- Prevents the risk of overloading
- Remote connect/disconnect the cars depending on the needs
- Remote troubleshooting



Telecommunication requirements

- Two-way (bi-directional)
- Real time and permanent communication
- Automatic detection & configuration
- Multicast ability



Telecommunications needs

The core technology requirements are low but guaranteeing the efficient use of Electric Vehicles and the safety of the users requires more bandwidth to control, monitor and act on the V2G application.

Scenario 4 – Home networking and Smart Home

Features

- Remote monitoring of home appliances
- Monitoring of heating/air-conditioning/lighting
- Networking of all home devices
- CCTV and security against intrusion
- Building Management System (BMS)
- Many others possible applications

Telecommunication requirements

- Two way communication
- Point-to-Multipoint communication
- Real time ability
- Coexistence between low and high data rates
- IPv6



High broadband for a future proof Smart Home

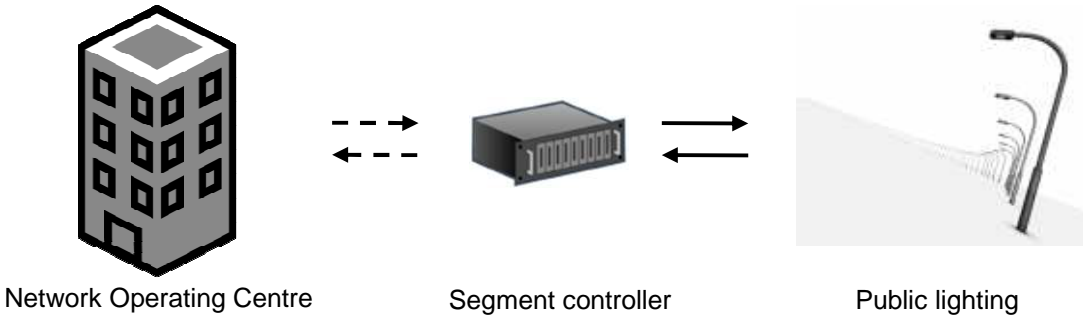
- Numerous customised new bandwidth intensive applications
- To be combined with multimedia and (ultra) broadband apps

Scenario 5 – Public Lighting

- Features**
- **Streetlight diagnosis and monitoring**
 - ⇒ Lamp failure detection
 - ⇒ System's health monitoring
 - ⇒ Data reporting (including burn hour data)
 - **On demand lighting**
 - ⇒ Remote power switching
 - ⇒ Remote light dimming / brightening
 - ⇒ Emergency light signals



- Telecommunication requirements**
- Two-way (bi-directional)
 - Multicast
 - Real time ability



- **Environmental sensors examples:**
- ⇒ Ambient light
 - ⇒ Traffic detection
 - ⇒ Motion sensor
 - ⇒ Pollution detection
 - ⇒ Power and voltage

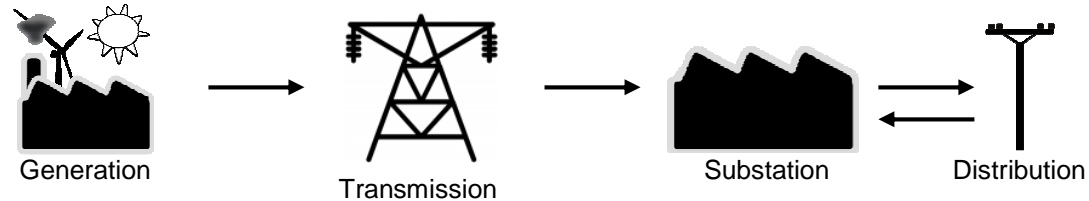


Specific needs
Long distance communication
Video surveillance
Direct identification of the lighting

Additional requirements
Communication with the central office
Broadband and medium latency
Complex location addressing

Characteristics needed
High number of hops or quality signal
3 Mbps per video feed, 200 ms latency max
IPv6

Scenario 6 – Network Automation



- 4 main components revolve around the data transmission
 - ⇒ Electrical protection
 - ⇒ Control
 - ⇒ Monitoring information
 - ⇒ Measurement

Features

- Remote substations monitoring and display of real-time information
- Remote switching and advanced supervisory control
- Interlocking and intelligent load shedding
- Disturbance and event recording aiding in detailed electrical fault analyses

Telecommunication requirements

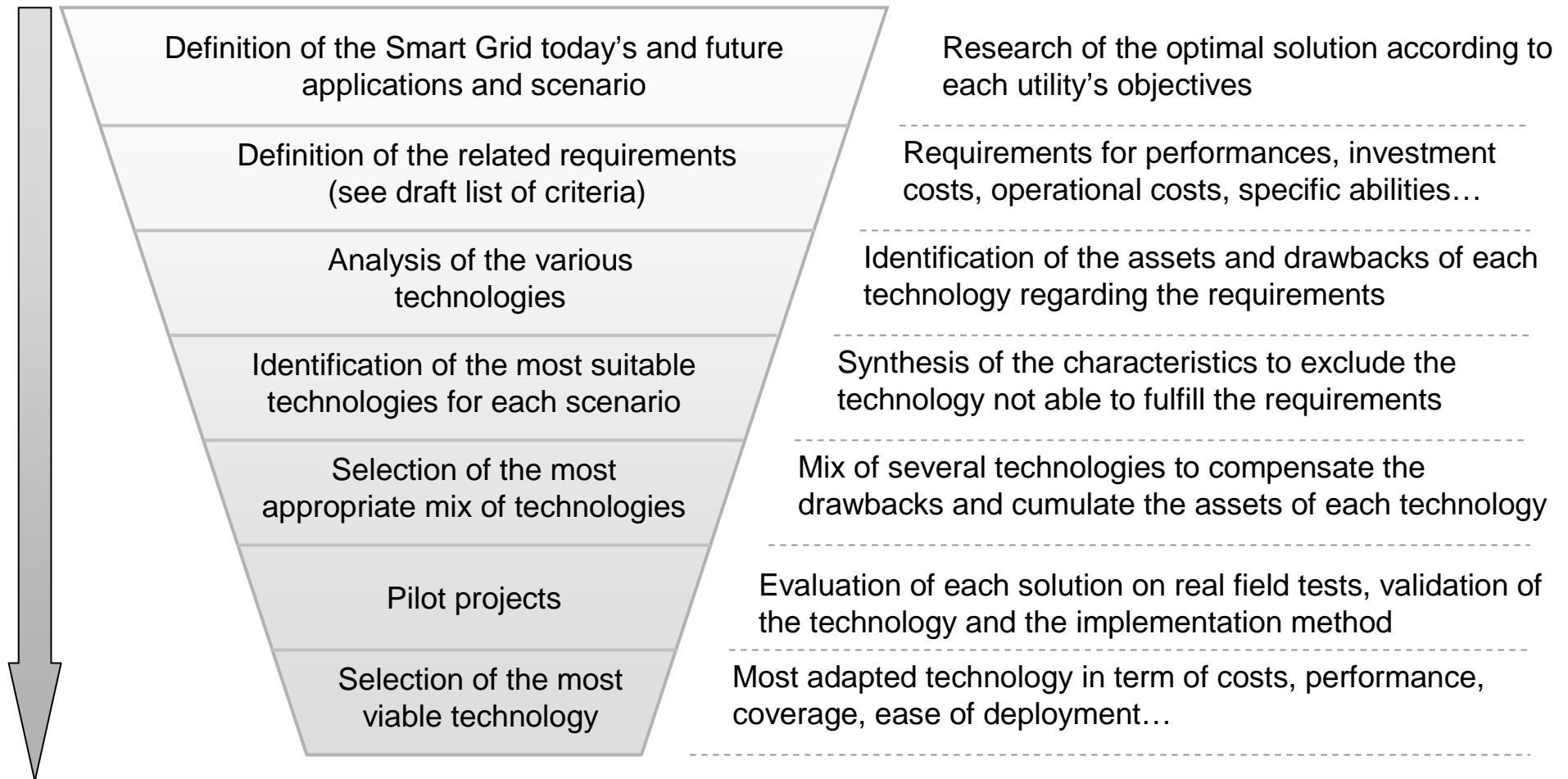
- Two way communication
- Real time communication
- Robust and error-free

- The performances level is different for the 4 main components of network automation



Main components	Level	Characteristics needed
Measurement and Monitoring information	Low	Data rates < 10 kbps; response time > 1s; time synchronisation around 1s; some errors allowed
Electrical protection and Control	Medium to High	Data rates > 10 kbps, response time 1s down to 0ms; time synchronisation between 1ms and 1µs; limited or no errors allowed

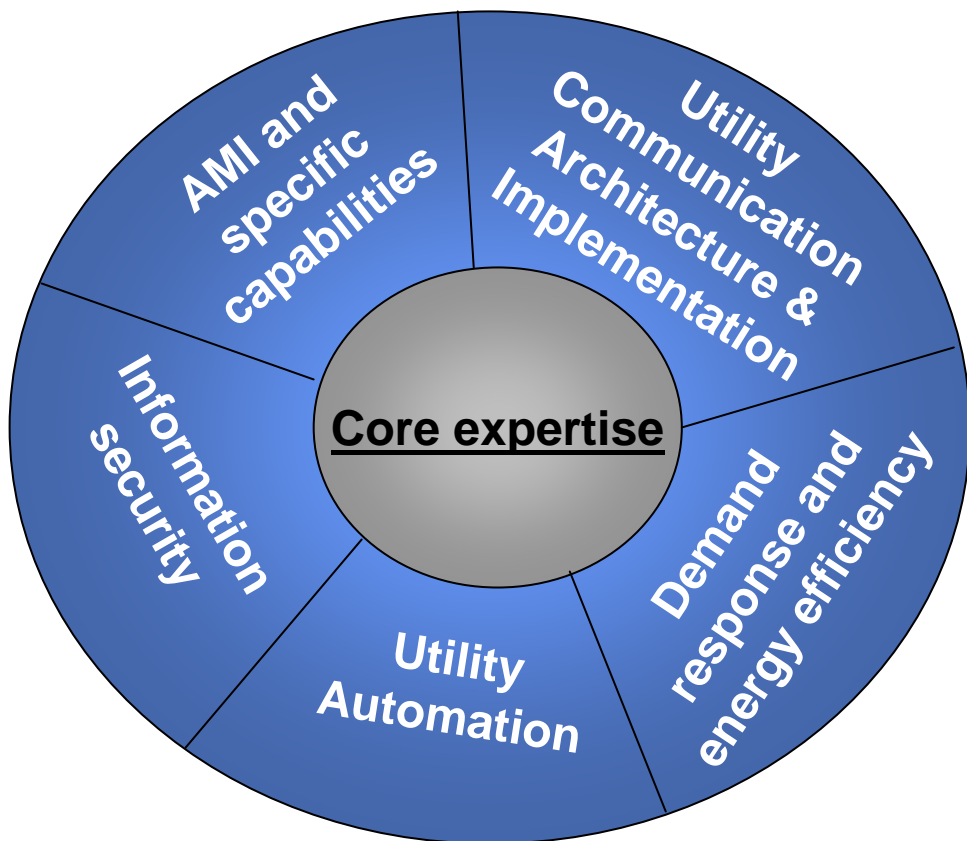
From the scenario to the most viable technology



Analysis to be conducted to select the most viable and future proof solution ! On the basis of the return of experience of other projects and the deep going knowledge of the technologies being proposed by telecom operators, utilities consortia & manufacturers

Enhanced expertise within Smart Grid

A deep-going experience through numerous projects with utilities and other stakeholders!



Some of our projects*

	Germany Advanced market study about the Narrowband PLC for Smart Metering
	USA Customized technology development and integration roadmap for Smart grid project
	Canada Customized technology development for SG project, help to develop and prioritize a database for the AMI system
	Morocco Analysis /business plan related to the implementation of (broadband)IP onto the electrical network, set up of pilot project and recommendation for a national roll-out
	Senegal Concept definition of a broadband IP AMM solution for MV
And many others !	



*bmp TC & associates



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